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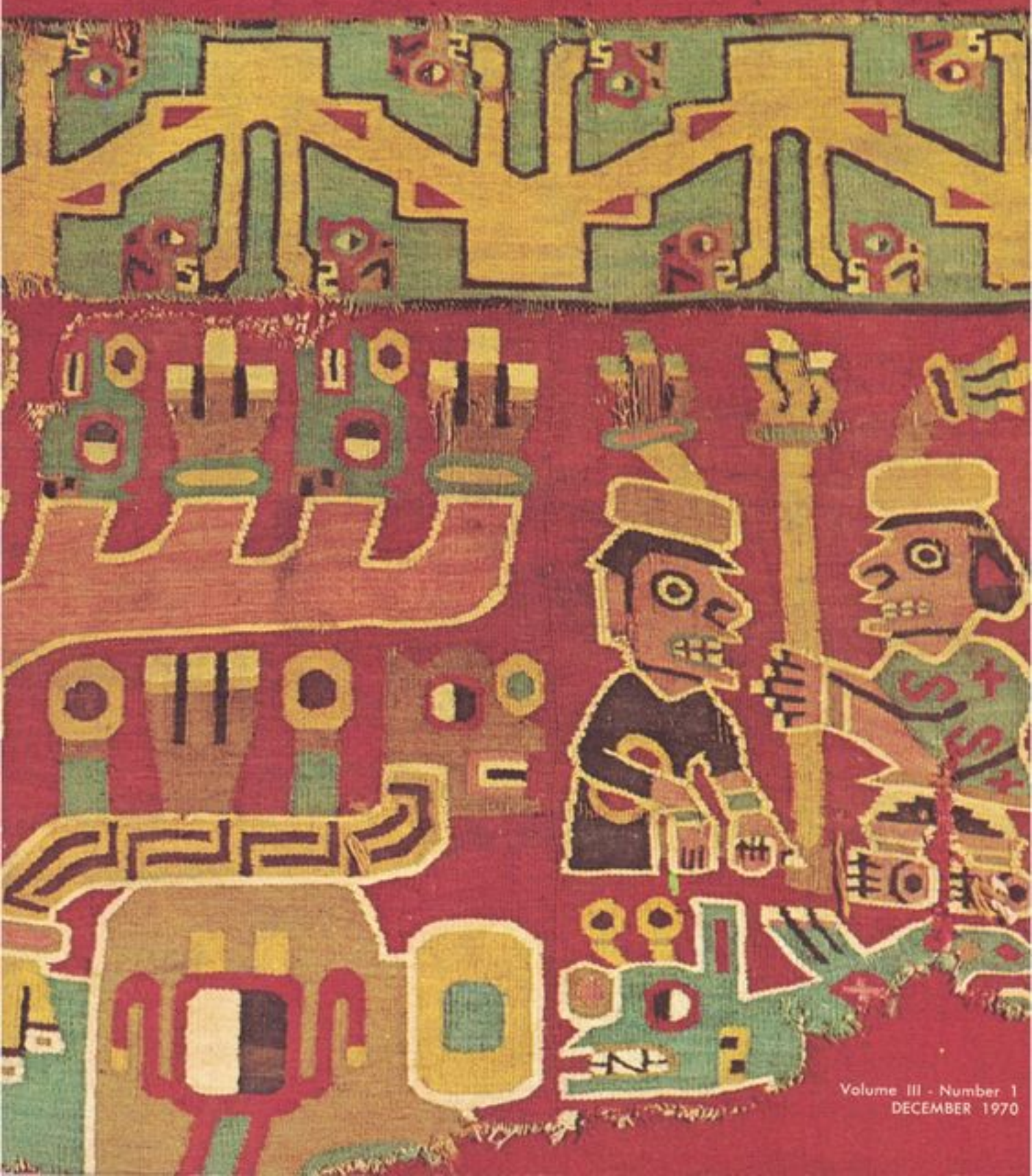

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THE CHARACTERISTICS OF SOILS AND STAINS ENCOUNTERED ON HISTORIC TEXTILES

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Why Is Knowledge Of Dirt and Soil Important In Conservation and Restoration Of Textiles?

Very many old specimens of unique historic garments, fabrics and textile fragments are found or received by museums and study groups in such a dirty and uncared for condition that our ingenuity is challenged to make them attractively presentable. Primarily, for aesthetic reasons, cleaning is necessary but it often happens that accumulations of various deposits may contribute to degradation of the fibers or the dyestuffs. Such deposits frequently obscure the structural details of the yarns and fabrics and hide colors and patterns. Unless this is removed, we cannot enjoy the full beauty of the specimen.

Occasionally, the soil matter itself may provide clues to events in the history of the specimen.

Because the composition and type of the soil will indicate how to clean a specimen, a study of the dirt before attacking the job is most important.

What Is Soil?

Soil or dirt, which are synonymous to a conservator, may be defined simply as "matter out of place." For example, soup in a bowl is food but on a garment it becomes soil. To elaborate, it may be any deposit or discoloration, irrespective of source, which is objectionable. Furthermore, it may not even be visible as long as it can be detected by some other sense, such as odor or touch. The definition is so broad that it is evident that there is no such thing as a "standard" or "average" soil and that the cleaner must try to deduce the source before he can remove it intelligently. This also suggests that removal treatments and techniques must be adapted to the individual soil substance. Fortunately, this is less formidable in practice than it sounds.

What Are Some Of The Common Soils Encountered On Historic Textiles?

As may be imagined, a listing of all the possible soils would be tedious and probably confusing, but by grouping them into a few classes we can simplify our knowledge so that it may not appear so appalling. Two more or less related systems of classification will thus be suggested. First, we can place many of the soils according to how they may be deposited. This has value to the conservator from the point of view of identification and may indicate something of a specimen's history. This leads to a second classification which would list the soils according to probable removal processes. Both systems are interdependent to an extent.

From the point of view of soil source Table I, a classification scheme which may be helpful, is offered:

Table I—Sources Of Soils On Historic Textiles

1. Airborne dusts, including sand
2. Earthy substances, clays, humus, peat, silt
3. Mineral matter, salts, rust, corrosion
4. Blood and body decomposition products
5. Food spots, starches, greases
6. Body contact oils, perspiration, etc.
7. Cooking greases, candle and lamp deposits
8. Soot and smoke stains
9. Other atmospheric condensation products
10. Fiber decomposition products, lint
11. Decomposed adhesives and finishing agents
12. Water stains, dye transfer accidents
13. Mildew and fungi
14. Transfer accidents, paints, inks and others

From Removal Techniques Considerations, How May The Several Source Groups Be Further Reclassified?

For practical considerations, we may reclassify the above soils into four main compartments such as:

1. Air removable
2. Wet cleanable
3. Drysolvent cleanable
4. Insoluble and unresponsive

Each of these may be still further divided into appropriate subclasses, all of which will be discussed and explained below.

What Are The Characteristics Of Air Removable Soils?

Air removable soils may be wind borne deposits of dust or sand. Often, however, they are due to some other contact or source. A few such other substances that may respond to air cleaning are particles of degraded fibers, lint and entangled fibrous masses, smears from contacts with dirty surfaces or with the earth.

No matter what its origin, a soil particle that falls into this class should have the following five properties: 1. It should be of low density or have a large surface area compared to its mass. Since we depend on the vacuum or blast velocity of the air to carry it away, it must respond to the lifting principles of high speed air much as employed by airplanes in taking off. 2. The particles must be large enough so as not to be entrapped in the fabric and fiber pores. 3. The particles should not be sticky or adhesive in nature. 4. The surface of the soil particles should not be smooth. Roughness would lessen the tendency for cohesion to the fiber. 5. The soil particle should not retain electrical charges and thus build up electrostatic attraction forces to the fiber.

The blast or suction force of air cleaning is sometimes not able to dislodge a particle and in this case additional energy in the form of brushing, sweeping, tapping or shaking may be required. Any of these must be done with care lest the fabric be damaged.

Air cleaning of fabrics is not likely to cause shrinkage, dye or color changes, nor, with reasonable precautions, mechanical damage to the textile. On the other hand, actual soil removal is limited and seldom fully satisfactory. It is however, a valuable and popular first treatment for many articles to remove some macrosoil before trying other cleaning methods.

What Are The Wet Cleanable Soils?

These are the deposits and stains that respond to treatment in water. But since water alone may act very slowly or only to a limited extent on many of these, we change its activity and speed by certain types of additives. There are seven of these and if we include plain water we may further divide this main class into eight subgroups such as:

1. Soils that dissolve in water alone
2. Soils that respond to alkaline solutions
3. Soils that are best removed by acids
4. Substances that require digestion
5. Stains that must be bleached or oxidized
6. Deposits that may be removed by strippers or reduction
7. Substances that may be dissolved by help of sequestrants
8. Insoluble dirt that can be emulsified by detergents

Unfortunately, many soil substances are more complex than this classification implies, so in practice we may have to employ more than one of these suggested removal remedies at the same time or in sequence to accomplish the cleaning objective. These will be discussed under characteristics of each of the above soil types.

What Are Some Soil Substances That May Be Dissolved By Water Alone?

Plain water is an excellent solvent for many inorganic salts such as common table salt or sodium chloride and similar crystaline substances. Such soils are occasionally encountered on textiles recovered from desert burial sites and, as one might suppose, seem to help preservation. Exceptions, however, are ferric iron salts which will contribute to the degradation of both cotton and wool fibers.

A good many organic compounds also of a crystaline nature, such as sugars, are readily dissolved by water. As a rule this class of soils becomes more soluble as the temperature of the water rises. The dissolving rate of these may also be increased by small amounts of wetting and solubilizing agents which are also functions of detergency. These will be described more at length in the discussion of detergent action later in this series of technical papers.

What Are The Characteristics Of Soils That Respond To Treatment By Alkaline Solutions?

Certain stains and deposits that are normally unaffected by pure water may dissolve if the ionic activity is alkaline. For example, alkalies in solution will react with acid substances to form products that will dissolve more readily in the water. Most organic matter oxidizes to form acidic type soils which follow this pattern. Sugars, starches, cellulose fibers are of this nature. Many animal and vegetable fats, oils and greases that are insoluble in pure water will combine with alkalies to form soaps that can be dissolved. Glues and proteins, as for example residues from body decomposition processes, can be broken down into more soluble products by very strong alkalies. Very many dyes of the "acid" dye class and numerous vegetable, fruit juice and wine stains also can be rendered more soluble by alkalies in the water.

A few cleaning agents that will make water alkaline are true soaps, ammonia, ethanol amines and a group of chemicals called alkaline salts or "laundry builders." These last produce limited alkalinity conditions, which is known as buffering, when dissolved in water. Some of the better known builders are borax, modified soda (half washing soda and half baking soda) and a group of special chemicals called polyphosphates. These are relatively safe for museum textiles if used quite dilute.

Presence of alkalinity in solutions may be determined by pH tests. This is a system of comparing the ionic activity by a range of numbers from 0 to 14. A simple way of determining these numbers is as follows: a strip of commercially available pH indicator paper is dipped in the water. When wet, it will change color to a some one difinite hue which corresponds to a pH number. If the activity of the water is changed, the hue and its corresponding number changes also. A color chart on the paper strip container provides the pH number of the several possible hues. A low pH number from 0 to 7 indicates acidity, pH 7 is neutral and represents pure water. A high pH number 7 to 14 as a maximum indicates alkinity. Numbers of 10 to 14 are quite harshly alkaline. Numbers of 0 to 3 are considered corrosively acid.

In proper proportions acidic and alkaline solutions will counteract or neutralize one another. This is an important principle in cleaning work as well as in chemistry.

The points just discussed are summarized in Figure 1, *Practical pH Guide.*

PRACTICAL pH GUIDE

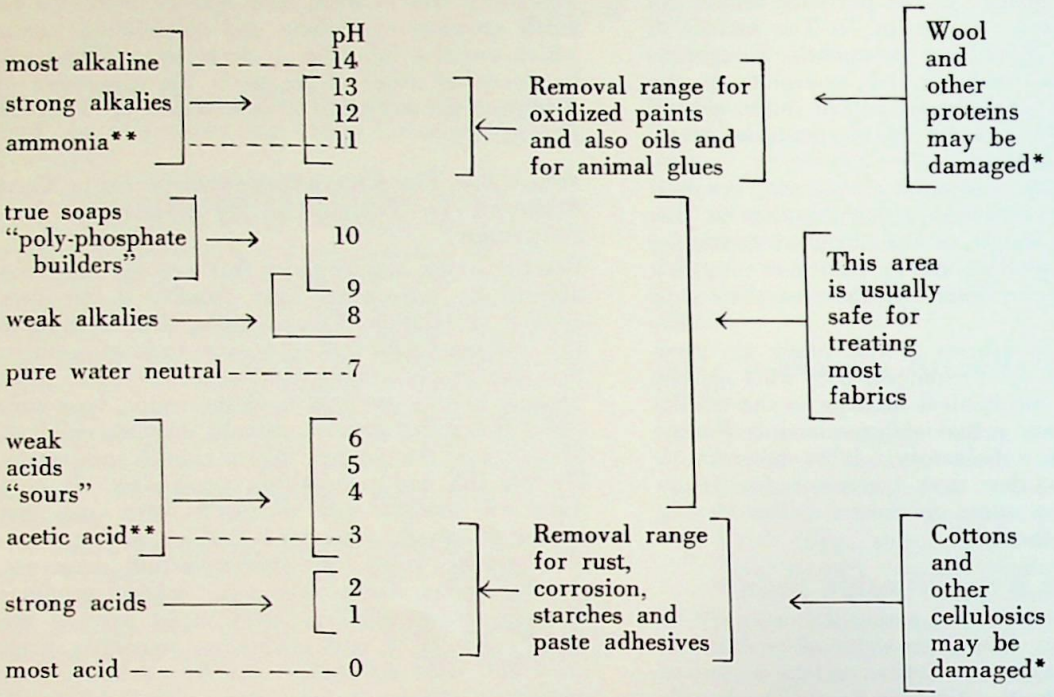


Figure 1

*The extent and seriousness of the damage will depend on the condition and age of the fibers, the time of contact and the temperature of the solution.

**These pH values are for concentrations of about 0.1% or less. Both ammonia and acetic acid are volatile and will disappear in a short time, usually before the fabric is damaged.

What Are The Characteristics Of Soils That May Respond To Acidic Solutions?

Alkaline or basic (a broader chemical term which includes it) soils and stains are much less common than the acidic types previously mentioned. They are often changed or made more soluble by treatment with acid solutions. Examples of substances that respond to acids are rust and metallic corrosion deposits, a few other minerals, occasional dyes, and unrinsed soaps and builders.

Useful chemicals for producing the necessary acid conditions are acetic acid, formic acid, hydrofluoric acid, and a group of fluoride compounds known as "permanent laundry sours." These are acid salts which produce limited acidity when dissolved in water. Here again is another example of "buffering" action.

What Substances Might Yield To Digesters?

There are a number of common soils and deposits which, while they might yield to strong concentrated alkaline or acid solutions, can be removed with less potential damage to the fibers and dyes by digestion.

Digesters are enzymes such as occur in living animals and plants for the purpose of converting insoluble foods into a more soluble and usable form. In other chemical technology we would call them catalysts, meaning substances that promote and speed up chemical actions. A remarkable fact about the use of digesters is that a small amount in solution will do a great deal of work. Otherwise difficultly soluble soils that are readily converted to more soluble substances by these digesters are such things as glue, gelatin, blood, partly decomposed

animal matter, milk products, starches, sugars, mucilages, library pastes, dextrines and many food spots.

Commercial digesters which will attack any of these can be obtained through cleaning supply houses and are used in a tepid bath (not more than 120°F) at the rate of about one teaspoon to a quart of water. The fabric is immersed for about one-half to two hours and then rinsed. The digestion bath should be neutral (pH 7).

Very old silk and wool, where the chemical resistance is weak or where the fiber has been damaged previously by chemicals, may suffer further degradation and weakening under digestion. While such cases are rare, the possibility should be considered in making a decision on this cleaning technique.

What Are Some Of The Stain And Soil Types That May Be Cleaned By Bleaching?

Bleaching or controlled oxidation is effective on absorbed stains and colored soils that do not respond to any other cleaning processes or agents. In fact, it is usually considered as a last resort or desperation treatment. Because it usually weakens the fibers and is definitely hazardous on most dyestuffs, it should be used, if at all, on old textiles with very great caution and with carefully planned controls.

Stains that may have to be bleached are those that are the result of accidents in use, previous cleanings, or in storage, and which are so unsightly that they cannot be condoned. Examples are fruit juices and food spills, beverages, ink spots, pet accidents, contact stains from vegetation, from unprotected furniture such as chair and table legs and other wet colored fabrics and objects, and dye bleeding from a colored figure or pattern to adjoining areas of lighter hue in the same textile.

One very common disagreeable stain that is seen in old white cottons, linens or papers is a tan to brown discoloration which is a result of slow oxidation of cellulose. The color substance appears to resemble an acid dye and which has no affinity for cellulose itself but will stain wool and other protein fibers to nearly indelible condition. It resembles carmelized or brown sugar in color and action. It may be decolorized on the cellulose fibers by bleaching and in commercial practice nearly all white cottons and linens are bleached sometime during washing. In this case, the most effective bleach for the purpose is some one of the common hypochlorites. Unfortunately, these hypochlorites will damage wools and silks. Hydrogen peroxide or substances that produce it are much less damaging to the proteins but are also less effective on the cellulosic degradation type of stains.

Scorched areas if not actually charred and carbonized may be lightened in color by bleaching. Mildew and fungi discolorations will also yield to bleaching. In both of these cases hydrogen peroxide is applied and the fabric exposed to sunlight to activate nascent oxygen quickly in place.

Bleached cellulose must not be dried in an alkaline condition since this fosters the formation of the brown stain substance. This is one reason why cleaned white goods are always treated with a mild acid to neutralize any remaining alkalies before drying.

What Soils Respond To Reduction Or Stripping Action?

Reduction is the opposite chemical action to oxidation. Instead of adding oxygen or increasing valence, it implies taking away oxygen, adding hydrogen or reducing valence. "Stripping" is associated with dyeing and may be defined as controlled reduction.

The colors of many organic dyestuffs may be changed spectacularly by the action of reducing agents on certain of the chromophores[1] in their molecular structure. This results in fading or even decolorization. Quite often this is a reversible phenomenon and exposure of the reduced dyestuff to oxygen or some oxidizing influence causes a return to the original color.

Among the many dyes and stains that are affected by reducing agents, the vat dye class[1] are well known examples. Strippers will change the colors of these and also cause them to become soluble.

A number of metallic corrosion soils act in a similar manner. Ferric iron or rust, manganese and cupric copper will change color when reduced. The resulting ferrous iron and manganous compounds are soluble and can be washed out, or more readily sequestered by chellating agents as discussed under the next topic.

Popular commercial dye strippers are found in such chemicals as sodium hydrosulfite or formaldehyde sulfoxalate which are sold under a number of trade names. For reduction of stain colors, titanous sulfates or chlorides, which are purple liquids are popular with commercial cleaners. Iron rust responds to hydrofluoric acid and also citric acid. Ascorbic acid affects copper stains. These acids are well known reducing agents.

The success of any of these agents depends as much on the techniques employed as on the stripper used. For this reason, we would not recommend employing them without specific experience or instructions which we hope to provide in future technical papers.

What Soils Are Affected By Sequestrants?

Sequestrants or chellating agents, terms that, for our purpose, are chemicals that form soluble complex ions out of elements which tend to produce insoluble substances. For example, soap in hard water is precipitated by soluable calcium ions as lime soap curds, or bathtub ring, a form of soil frequently found on textiles. The soap curds can be dissolved or prevented by adding a little Calgon* or sodium hexametaphosphate (a polyphosphate). The Calgon* is a complex ion compound that exchanges some of its sodium atoms for the trouble making calcium in hard water or lime soap and

ties it up in their place. This is illustrated by the following chemical equation:

Sodium Hexametaphosphate—Calcium ions

Na_2 Sodium $[Na_4 (PO_3)_6]^+$ complex ion + $2\,Ca^{++}$ hard water or lime soap ⟶ $Na_2 [Ca_2 (PO_3)_6]^+$ sequestered calcium + $4\,Na^+$ soft water or soluble soap

Sodium ions

Besides the calcium in lime, polyphosphates which are similar to Calgon* are found as additives to many well known brands of synthetic detergents and have sequestering action on magnesium, ferrous iron, zinc, copper, and other divalent metals. Another even more active and supposedly more general sequestrant for these metals is E.D.T.A. (ethylene diamine tetra acetic acid) which can be bought under such trade names as Sequestrene* and Versene*. Copper corrosion can also be dissolved by ammonia and various amines but in these cases the resulting cupra-ammonium complex may become a solvent for cellulose. Sodium and potassium cyanides, both of which are dangerous poisons, will attack silver tarnish and dullness on gold alloys by complex ion phenomena. As mentioned previously, ferric iron or rust is decolored and dissolved by hydrofluoric acid. Oxalic and citric acids are also rust removers. In these three cases, however, there is first a reducing action which is probably followed by a complex ion formation. The products must be rinsed thoroughly lest the rust stain develops again on reoxidation.

What Are The Characteristics Of Soils That Must Be Emulsified?

There are a great many substances that cannot be changed or made soluble by any of the treatments discussed up to this point. These things are insoluble in water, and tend to adhere to the fiber or in the fabric structure either by a glue like adhesion or by surface attraction force. These may be either the strong molecular bonding between closely placed molecules which we will call "Van der Waal's effect"[1] or an attraction because of opposite electrical charges. It is quite likely that both of these theories are accountable for ordinary soiling cases.

At any rate, removal of these tightly bound soils demands help in overcoming the very strong attraction between the soil and fiber surfaces and in maintaining separation until it can be carried away from the influence of these forces. Although in practice the need for these aids in cleaning was discovered and applied before recorded history, it has only been recently that we have understood them and developed reasoned improvements and practices.

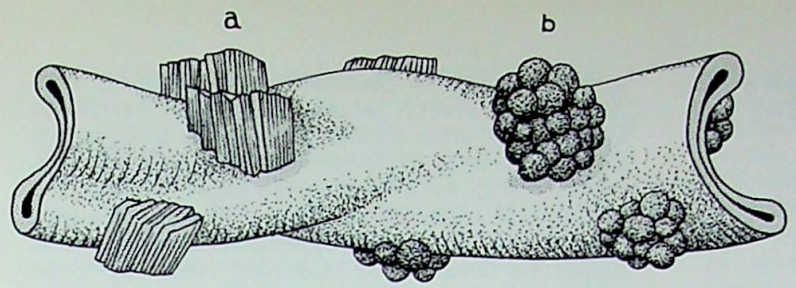
In these improvement studies, which are really within the purview of detergency, we have a need for certain assumptions and proofs about the character, shape and particle size of these soils.

For example, we may assume that most of the insoluble matter we encounter on textiles is either clay-like finely divided earthy minerals or condensed air borne carbon and oily mixtures such as soot which also will be finely divided because of the manner in which they are deposited. The clays (Figure 2-a) are capable of being subdivided into minute lath-like or plate-like forms which are very thin but have at least two surfaces that are quite large in proportion to the particle mass. The soots (Figure 2-b) and other carbonaceous particles seem to form tiny structures, roughly cubical to globe-shaped, but which may also be adhered together in a larger collection by condensed oily matter.

Both of these soil types are capable of great surface covering power. The carbonaceous particles have a strong tinctorial effect whereas the clays, when deposited on the fiber, have affinity for coloring matter such as iron and stain substances and thus add to the greying of fiber appearance.

In size, this author has assumed that an average strongly adhered plate-like clay soil particle is about 1/10th of a micron or 1/10000 of a milimeter in diameter and very much thinner.[2] Carbon deposits that exhibit strong greying power appear to be about 1/20th of a micron in diameter. This is in the neighborhood of the dimensions of the width of the crevices in the surface of a cotton fiber and the junctures of wool scales.[3] Thus the appearance and the tenacity of the soil adherence may be due in part to deposits within the natural roughness fissures of the fibers.

A natural question arises at this point which is: How can these soils be broken down into such fine particles? The answer is that it is the result of the action of water in some way. Perhaps the most obstinate of all soils are those that settle out from muddy water or uncontrolled wetting. Naturally dirty waters and spent washing waters have some of the characteristics of detergents. Soil particles in muddy waters, especially if they contain natural emulsifiers such as may be found in decayed organic matter or even some minerals, will become dispersed into very minute subdivisions and will



How Redeposition Occurs:

Figure 2-a *Clay-like macrosoil*
2-b *Carbon-like macrosoil*

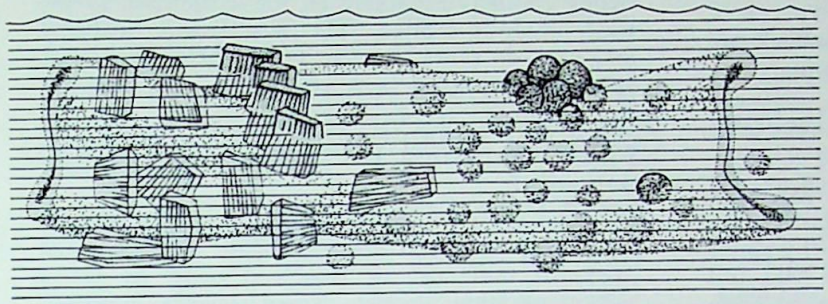


Figure 3 *Particles break up in emulsifier*

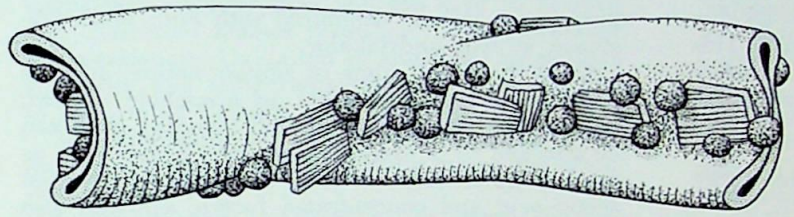


Figure 4 *Particles deposit in fiber irregularities*

remain so until the ionic or electrostatic energy status of the water mixture is upset. Flocculation and depositing of these sub-particles on convenient surfaces such as the fibers in contact with the water may be caused by adding salt, alum, acid or other sources of ions or by drastic changes in the state of agitation of the liquid, either by complete arrest or by violent stirring. In any of these cases, these sub-particles, at the moment of contact, seem to be very fine and have very great attraction for the fiber surfaces. The net result is much resistance to removal. This is called redeposition and becomes a most difficult cleaning problem. It is illustrated by Figures 3 and 4. Perhaps this will become clearer after an explanation of the objectionable properties of soils.

Besides lack of solubility in water, these soil types have five adverse characteristics that make them resistant to cleaning. These are:

1. They repel water and cannot be penetrated or wetted easily.

2. Before they can be removed, their natural stickiness or attraction for the fiber surface must be overcome.

3. Once loosened from that surface, they must be broken up and suspended in water before they can be flushed away.

4. After suspension, any tendency for them to coagulate and settle out must be discouraged.

5. Should the soil particle accidentally recontact the cleaned surface, something must be done to keep it from re-adhering.

The above list will provide clues to detergency and the surface activity requirements for an ideal cleaning agent for these and even many dissimilar soils. Very many soaps and ancient and modern detergents have the necessary qualities to overcome these adverse characteristics. However, an adequate exposition of the subject of detergency and specifications for suitable detergents in detail is a project which we have reserved for a future report because of the profound and unique theories necessary in explaining how they work.

What Soils Are Insoluble Or Unreactive To Water Treatments But Respond To Dry Or Non-Aqueous Solvents?

In general, there are four subclasses of soils that will not dissolve in water but can be dissolved or softened by dry cleaning fluids or special solvents. These are:

1. The non-drying oils, greases and waxes.
2. The drying oils.
3. Resins and films that can be attacked by special solvents.
4. The insoluble soils that may be swelled and softened and eventually removed by scraping.

What Characterizes The Non-Drying Oily Soils?

The non-drying oils are composed of saturated hydrocarbon esters. By this we mean that a number of carbon atoms are joined in a chain by single bonds between successive carbons and will not accept more hydrogen atoms. The saturated compounds are very stable and do not accept oxygen readily nor change on aging. They are readily dissolved by dry cleaning solvents and can be emulsified by detergents or soaps or saponified by alkalies in water, especially at elevated temperatures. This class is represented by many unrefined crude petroleum fractions and some hard animal and vegetable fats and greases.

What Are Drying Oils And How Do They Differ From Non-Drying Oils?

The drying oils are composed of unsaturated hydrocarbon esters. In this case, the hydrocarbon chain has one or more pairs of carbon atoms that are joined by two or three valence bonds between. They are called unsaturated compounds because they can accept two or more hydrogen atoms. The unsaturated oils will take up oxygen from the air and in doing so join with other similar molecules to polymerize and form hard films and deposits. This is the way that paint dries. The linseed oil in an oil paint is a drying oil. Others are tung oil, soy bean oil and like substitutes. Unsaturated oils occur in many animal and vegetable oils, olive oil being an example.

Some unsaturates produce objectionable odors on oxidizing. This is a case where the soil can be recognized by sense of smell but it may not be seen.

When fresh, unsaturated oils dissolve quite readily in dry cleaning solvents such as petroleum distillates or chlorinated hydrocarbons such as perchlorethylene. A hardened or dried film, however, may not yield to petroleum distillates but may be softened by some active chlorinated hydrocarbon such as chlorofom or methylene chloride. These may be toxic. Benzol, toluol, and xylol are paint solvents of considerable power also but are toxic too. Commercial paint strippers, not to be confused with dye strippers discussed previously, are mixtures of the several solvents mentioned previously together with other additives such as acetone, formic acid, and special synthetic detergents, and are usually successful for removing old paint deposits.

Very old oxidized oil films and food deposits, burnt grease and similar objectionable deposits that cannot be softened or dissolved safely by paint strippers without damage to the fabric or dye, may respond to a powerful alkali such as concentrated ammonia. In this case, soap formed in place has a strong emulsifying action on the carbonized grease when water is applied. This is a drastic treatment and may do more damage to a fabric than good. In conservation, it is a last resort operation.

What Are Some Of The Resins And Other Films That Must Be Treated With Special Solvents?

Chief among the foreign deposits that may respond to special solvents are varnishes and lacquers. Many of these can be dissolved easily by either methyl or ethyl alcohol. These solvents, however, are also powerful dye solvents and must be used with great caution. Methyl alcohol is quite piosonous and ethyl alcohol as obtainable for solvent purposes is usually denatured with some toxic substance, so it is undrinkable.

Other hardened films of similar nature, such as cellulose nitrate or acetate in household cement, nail polish, lacquers and similar mending glues can be attacked by a variety of special solvents such as amyl acetate, ethyl acetate, and acetone. Glacial acetic acid and concentrated formic acid are also solvents for these cements. The formic acid above 10% concentration is used to dissolve nylon adhesives.

Benzene or benzol, in its less pure grade, is effective on acrilonitrile adhesives. Toluene and xylene are slightly less efficient but safer from toxicity and fire hazard standpoints.

Besides the alcohols, pyridin is rated as a dye solvent and may reduce the color intensity of some stains without damaging the fiber. It has a penetrating and revolting odor, and is not a popular reagent. It is toxic also.

There are many hundreds of solvents, some of which are quite special and act on one substance but not on others. An example that almost fits this statement is hydrofluoric acid which will dissolve or etch glass but does not seem to harm most textile fibers. Occasionally some substance can be dissolved in a mixture of solvents. This was illustrated by the discussion of very old paint.

What Are Some Substances That May Not Dissolve In A Solvent But May Be Softened To A Point Where They May Be Scraped Off?

Probably the best examples of such obstinate substances are the rubber latexes used for backing modern carpets and upholstery materials. Rubber

may sometimes be dissolved by benzene, toluene or xylene. Carbon disulfide, a poisonous, explosive and highly volatile liquid, is also a very good rubber solvent. But, if the rubber is well vulcanized and cured, it may not liquefy but merely soften and swell. At this point it may yield to scraping. This behavior is more apt to be true in the case of synthetic modern rubbers than in natural latexes. Contact areas and other accidental smears of rubber are common on mended and patched floor coverings and many modern carpets and upholstery fabrics are stabilized by rubber backings which sometimes bleed through to the face. These latex backings cannot be drycleaned safely.

What Are Some Soils And Stains That May Be So Insoluble That They Cannot Be Removed Successfully Without Damaging The Fabric or Dyes?

A few cases of insoluble substances that do not respond to safe cleaning endeavors are:

1. Products that have been oxidized to a point where the fiber or soil composition has changed irreversibly. Carbonization or deep scorch by charring in place is an example. In less advanced cases, sugars, starches and cellulose oxidize to colored stains that resemble dyes and are hard to remove.
2. Hardened masses resulting from irreversible polymerization. Oxidation of some oils or modern synthetics and temperature induced changes such as in forming Bakelite, are examples.
3. Accidentally mordanted natural coloring substances and stains of which tannin stains are examples.
4. Dehydration products as in some modern paints may resist re-absorbtion of water lost by evaporation or in chemical reactions.
5. Hydration products may result wherein moisture either from the air or from other sources forms insoluble hydrated masses, as in the case of plaster of Paris.

How May An Unknown Soil Be Recognized?

Unless the authenticity of a specimen is in question, a precise identification of a soil is seldom necessary. Usually all that is required is some means of determining its cleaning type and characteristics. Sometimes mere experienced visual observation is good enough. For example, does it seem to be dusty and can one remove the soil by merely blowing on it? Will gentle scraping as with a fingernail or wooden applicator loosen the soil without damaging the fiber or yarn structure? Does a hard resistant mass yield to wetting or scraping after a little detergent and water is applied? Does one get a visible transfer when a cotton-tipped medical applicator moistened with the detergent appears stained when rubbed gently on the soil? Will a similar applicator, moistened with dry-cleaning solvent, pick up visible discolor or soil? What are the results of similar tests using alkali and detergent, acid and detergent, or the various special solvents such as alcohol, acetone, benzol, amyl acetate and others? Does hydrofluoric acid (any trade named rust remover) produce a notable change in the soil when applied? Does the specimen contain any metallic embroidery or gilt threads?

In this way, the soil class may be established by the appropriate cleaning agent but one must realize that a single specimen may be contaminated by several different types of soil, all in different sections. In this case, we may have to examine the textile closely and plan a stepwise succession of treatments.

What Are Some Of The Individual Soils And Stains?

In summation, the following listing of a number of common soils and stains is presented in the table that follows. This is intended as an aid in selecting some of the possible cleaning techniques that may be expected to produce results. Where one is not effective, another may do the job. *We must emphasize,* however, *that success in cleaning depends as much or more on the correct procedures and techniques as it does on the cleaning agents.*

Some of the instructions and techniques for cleaning very old and fragile problem textiles have been published in the Textile Museum's *Workshop Notes,* Numbers 1—"Cleaning and Mounting Procedures for Wool Textiles," 4—"Procedures for Cleaning Cotton Textiles," 8—"Preservation of Dated Tiraz Fabrics," 14—"Principles of Practical Cleaning for Old and Fragile Textiles." In general, these are concerned with conservation of very old specimens and do not include many of the special methods mentioned in the foregoing article. A practical manual providing stepwise procedures and precautions to cover the techniques not found in these papers is in course of preparation and will be published at an early date. In the meantime this alphabetical listing may be of value in planning a job of cleaning.

(* signifies trade-marked products.)

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1959 *Textile Research Journal,* Vol. 29, pp. 879-889

[3] **Compton and Hart**
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Common Soils and Stains	Will Probably Yield To:
Acid	(1) Alkaline detergent
Acid dyes	(1) Alkaline detergent (2) Alcohol (3) Bleach
Adhesives, modern	(1) Drycleaning (2) Benzol (3) Amyl acetate (4) Acetone
Air deposits	(1) Vacuum (2) Drycleaning (3) Alkaline detergent
Albumin	(1) Digestion (2) Strong alkaline detergent
Alkali deposits	(1) Acid detergent (2) Rinse
Animal decomposition	(1) Digestion (2) Hot alkaline detergent
Animal glues	(1) Digestion (2) Hot alkaline detergent
Basic dyes	(1) Acid detergent (2) Stripper (3) Bleach
Berry stains	(1) Alkaline detergent (2) Stripper (3) Bleach
Blood deposits	(1) Digestion (2) Hot alkaline detergent
Brass	(1) Strong acid (2) follow by sequestrant
Browning, cellulosic	(1) Neutral detergent (2) Mild bleach
Burial	(1) Neutral detergent (2) Digestion (3) Neutral alkaline detergent
Candle grease	(1) Drycleaning (2) repeat
Carbon	(1) Dust cleaning (2) Neutral detergent
Cellulosic degradation, browning	(1) Neutral detergent (2) Mild bleach
Cement, building	(1) Strong acid (2) Lime sequestrant (3) Acetone
Cement, household	Special solvents—(1) Amyl acetate (2) Acetone (3) Benzol, etc.
Clay	(1) Alkaline detergent (2) Soak in neutral detergent
Condensates, airborne	(1) Dust clean (2) Alkaline detergent
Cooking oils	(1) Drycleaning (2) Paint stripper
Copper	(1) Mild acid (2) Sequestrant (3) Ammonia
Corrosion, general	(1) Mild acid (2) Sequestrant
Crayons, wax	(1) Drycleaning (2) repeat
Curds, soap	(1) Lime sequestrant
Decomposition, Fiber	(1) Dust clean (2) Vacuum (3) Neutral detergent
Direct cotton dyes	(1) Hot alkaline detergent (2) Bleach (3) Stripper
Dirt, ground soil	(1) Dust clean (2) Alkaline detergent
Dust	(1) Dust clean (2) Vacuum (3) Alkaline detergent
Dyes, general	(1) Detergent (2) Bleach (3) Stripper (4) Alcohol
Earthy clay	(1) Dust clean (2) Vacuum (3) Alkaline detergent
Egg	(1) Digestion (2) Alkaline detergent
Ferric Iron	(1) Hydrofluoric acid (2) Oxalic acid (3) Citric acid
Ferrous Iron	(1) Mild acid detergent (2) Neutral rinse
Finishing agents, oxidized	(1) Detergent (2) Mild bleach (3) Acid rinse
Food spots	(1) Drycleaning (2) Alkaline detergent (3) Digestion
Fruit juices	(1) Neutral detergent (2) Mild bleach
Fungus	(1) Mild bleach (2) Air in sunlight
Glue	(1) Digestion (2) Strong alkaline detergent
Graphite	(1) Vacuum (2) Alkaline detergent (3) Soap
Grass	(1) Neutral detergent (2) Bleach
Grease	(1) Drycleaning (2) Strong alkali
Greying	(1) Alkaline detergent soaking (2) repeat
Gutter splash	(1) Alkaline detergent (2) Soaking
Humus	(1) Alkaline detergent (2) Bleach
Imbedded soil	(1) Alkaline detergent soaking (2) repeat
Ink drawing, India	(1) Alcohol (2) Varnish remover (3) Alkaline detergent
Ink, modern	(1) Alkaline detergent (2) Bleach (3) Dye stripper (4) Alcohol
Ink, writing	(1) Oxidize (bleach) (2) Hydrofluoric acid (3) Neutral detergent
Iron	(1) Oxidize (2) Hydrofluoric acid (3) Rinse

Juices, fruit	(1) Warm neutral detergent (2) Mild bleach
Lacquer	(1) Alcohol (2) Varnish remover (3) Alkaline detergent
Lampblack	(1) Vacuum (2) Drycleaning (3) Neutral detergent
Latex	(1) Drycleaning (2) Benzol (3) Carbon disulfide
Lead or solder	(1) Liquid mercury to form almalgam
Lime soaps	(1) Lime sequestrant (2) Rinse
Manganese or permanganate	(1) Dye stripper (2) Hydrofluoric acid
Medicine	(1) Neutral detergent (2) Bleach (3) Dye stripper
Metallic	(1) Oxidizer (2) Reducer (3) Sequestrant
Mildew	(1) Mild bleach (2) Expose to sunlight
Mordant dyestuffs	(1) Acid detergent (2) Alkaline detergent (3) Alcohol (4) Bleach
Mucilage	(1) Digestion (2) Acid detergent
Mud	(1) Dust cleaning (2) Vacuum (3) Alkaline detergent
Muddy water	(1) Alkaline detergent (2) Soaking
Odors	(1) Vacuum (2) Odor masking agent or perfume
Oils	(1) Drycleaning (2) Paint stripper (3) Alkaline detergent
Oxidation products	(1) Alkaline detergent (2) Dye stripper
Paints	(1) Drycleaning (2) Paint stripper (3) Neutral detergent
Peat	(1) Alkaline detergent (2) Bleach
Pencil marks	(1) Neutral detergent
Perspiration	(1) Drycleaning (2) Neutral detergent
Pigments	(1) Drycleaning (2) Paint stripper (3) Neutral detergent
Plaster	(1) Mild acid (2) Sequestrant
Redeposition	(1) Alkaline detergent (2) Soaking
Reduction	(1) Oxidize with mild bleach
Resins	(1) Special solvents—Acetone, Amyl acetate, Benzol
Rosin	(1) Drycleaning (2) Benzol (3) Perchlorethylene
Rouge	(1) Hydrofluoric acid (2) Citric acid
Rubber	(1) Benzol (2) Carbon disulfide (3) Special solvents
Rust	(1) Hydrofluoric acid (2) Citric acid (3) Sequestrants
Salt	(1) Neutral detergent (2) Plain water
Scorch	(1) Mild bleach (2) Neutral detergent
Shellac	(1) Alcohols (2) Paint stripper
Silver	(1) Form silver Iodide (2) Reduce with theosulfate and ammonia
Smoke	(1) Drycleaning (2) Alkaline detergent
Soils, unknown	(1) Try to identify. See Unknown
Starch, oxidized	(1) Mild bleach (2) Neutral detergent
Sugar, oxidized	(1) Mild bleach (2) Neutral detergent
Sulfur fumes	(1) Alkaline detergent
Sweet	(1) Neutral detergent (2) Plain rinse (3) Bleach
Tannin	(1) Neutral detergent (2) Bleach
Tars	(1) Drycleaning (2) repeat
Tea	(1) Neutral detergent (2) Bleach
Tin	(1) Oxidize (2) Acid detergent (3) Reduce
Unknown	Test for response to all cleaning agents
Urine	(1) Neutral detergent (2) Mild bleach
Varnish	(1) Alcohols (2) Paint strippers (3) Special solvents
Vat dye	(1) Alkaline detergent plus Dye stripper (2) Rinse
Water	(1) Neutral detergent (2) Bleach
Wax	(1) Drycleaning (2) Benzol (3) Special solvents
Wine	(1) Neutral detergent (2) Bleach